

# INDOOR AIR QUALITY ASSESSMENT

**Department of Transitional Assistance  
Massachusetts Rehabilitation Commission  
35 Congress Street  
Salem, Massachusetts**



Prepared by:  
Massachusetts Department of Public Health  
Bureau of Environmental Health  
Indoor Air Quality Program  
February 2008

## **Background/Introduction**

At the request of the Human Resource Division and Kevin Preston of the Service Employees International Union (SEIU), the National Association of Government Employees (NAGE), the Massachusetts Department of Public Health (MDPH), Bureau of Environmental Health (BEH) provided assistance and consultation regarding indoor air quality concerns at the offices for the Department of Transitional Assistance (DTA) and Massachusetts Rehabilitation Commission (MRC), located in the Shetland Park Office Complex at 35 Congress Street, Salem, Massachusetts. On August 3, 2007, a visit to conduct an indoor air quality assessment was made to the DTA/MRC offices by Michael Feeney, Director of the BEH's Indoor Air Quality (IAQ) Program.

The Shetland Park Complex at 35 Congress Street is a four-story office building, reportedly constructed as a shoe factory in the late 1800s to early 1900s. The building was renovated in the mid-1990s, prior to occupancy by state offices. The DTA and MRC occupy space on the ground floor. Windows are openable throughout the building.

## **Methods**

Air tests by MDPH for carbon dioxide, carbon monoxide, temperature and relative humidity were taken with the TSI, Q-TRAK™ IAQ Monitor, Model 8551. Screening for total volatile organic compounds (TVOCs) was conducted using a Hnu, Model 102 Snap-on Photo Ionization Detector (PID). Air tests for airborne particle matter with a diameter less than 2.5 micrometers (PM<sub>2.5</sub>) were taken with the TSI, DUSTTRAK™ Aerosol Monitor Model 8520. MDPH staff also performed a visual inspection of building materials for water damage and/or microbial growth.

## **Results**

The MRC/DTA offices have a combined employee population of approximately 110 and can be visited by up to 200 individuals daily. The tests were taken during normal operations and appear in Tables 1 and 2.

## **Discussion**

### **Ventilation**

It can be seen from the Tables that carbon dioxide levels were below 800 parts per million (ppm) in all areas surveyed during the assessment, indicating adequate air exchange. However, it is important to note that a number of areas were unoccupied, sparsely populated or had windows open during the assessment, which can greatly reduce carbon dioxide levels.

Fresh, heated air is supplied by air-handling units (AHUs) equipped with high-efficiency pleated air filters. AHUs are located in mechanical rooms. Fresh air is drawn into the AHUs through fresh air intakes located on the exterior of the building and provided to occupied areas via ceiling-mounted air diffusers. Return air is drawn into ceiling-mounted vents and ducted back to AHUs. The majority of these systems were operating at the time of the assessment.

To maximize air exchange, the MDPH recommends that both supply and exhaust ventilation operate continuously during periods of occupancy. In order to have proper ventilation with a mechanical supply and exhaust system, the systems must be balanced to provide an adequate amount of fresh air to the interior of a room while removing stale air

from the room. It is recommended that HVAC systems be re-balanced every five years to ensure adequate air systems function (SMACNA, 1994). The date of the last balancing was not available at the time of the assessment.

The Massachusetts Building Code requires a minimum ventilation rate of 20 cubic feet per minute (cfm) per occupant of fresh outside air or have openable windows in each room (SBBRS, 1997; BOCA, 1993). The ventilation must be on at all times that the room is occupied. Providing adequate fresh air ventilation with open windows and maintaining the temperature in the comfort range during the cold weather season is impractical. Mechanical ventilation is usually required to provide adequate fresh air ventilation.

Carbon dioxide is not a problem in and of itself. It is used as an indicator of the adequacy of the fresh air ventilation. As carbon dioxide levels rise, it indicates that the ventilating system is malfunctioning or the design occupancy of the room is being exceeded. When this happens, a buildup of common indoor air pollutants can occur, leading to discomfort or health complaints. The Occupational Safety and Health Administration (OSHA) standard for carbon dioxide is 5,000 parts per million parts of air (ppm). Workers may be exposed to this level for 40 hours/week, based on a time-weighted average (OSHA, 1997).

The MDPH uses a guideline of 800 ppm for publicly occupied buildings. A guideline of 600 ppm or less is preferred in schools due to the fact that the majority of occupants are young and considered to be a more sensitive population in the evaluation of environmental health status. Inadequate ventilation and/or elevated temperatures are major causes of complaints such as respiratory, eye, nose and throat irritation, lethargy and headaches. For more information concerning carbon dioxide, please see [Appendix A](#).

Temperature readings during the assessment ranged from 74° F to 85° F, which were above the MDPH recommended comfort guidelines in some areas, mostly in the DTA offices. The MDPH recommends that indoor air temperatures be maintained in a range of 70° F to 78° F in order to provide for the comfort of building occupants. The elevated indoor temperature measurements were attributed to a breakdown in chilling equipment in the DTA area as well as record temperatures for the greater Salem area (Weather Underground, 2007). BEH staff reported this malfunction of HVAC equipment to Martha Goldsmith of Department of Capital Asset Management at the time of the assessment. In many cases concerning indoor air quality, fluctuations of temperature in occupied spaces are typically experienced, even in a building with an adequate fresh air supply.

The relative humidity measured in the building during the assessment ranged from 44 to 57 percent, which was within the MDPH recommended comfort range in all areas. The MDPH recommends a comfort range of 40 to 60 percent for indoor air relative humidity. Relative humidity levels in the building would be expected to drop during the winter months due to heating. The sensation of dryness and irritation is common in a low relative humidity environment. Low relative humidity is a very common problem during the heating season in the northeast part of the United States.

### **Microbial/Moisture Concerns**

A number of areas were observed with water coolers placed over carpeting. One area had water damaged carpet beneath the cooler. Water spillage or overflow of cooler catch basins can result in the wetting of the carpet. In addition, some coolers had residue/build-up

in the reservoir. These reservoirs are designed to catch excess water during operation and should be emptied/cleaned regularly to prevent microbial and/or bacterial growth.

The US Environmental Protection Agency (US EPA) and the American Conference of Governmental Industrial Hygienists (ACGIH) recommends that porous materials be dried with fans and heating within 24 to 48 hours of becoming wet (US EPA, 2001; ACGIH, 1989). If porous materials are not dried within this time frame, mold growth may occur. Water-damaged porous materials cannot be adequately cleaned to remove mold growth. The application of a mildewcide to moldy porous materials is not recommended.

### **Other IAQ Evaluations**

Indoor air quality can be negatively influenced by the presence of respiratory irritants, such as products of combustion. The process of combustion produces a number of pollutants. Common combustion emissions include carbon monoxide, carbon dioxide, water vapor and smoke (fine airborne particle material). Of these materials, exposure to carbon monoxide and particulate matter with a diameter of 2.5 micrometers ( $\mu\text{m}$ ) or less (PM<sub>2.5</sub>) can produce immediate, acute health effects upon exposure. To determine whether combustion products were present in the indoor environment, BEH staff obtained measurements for carbon monoxide and PM<sub>2.5</sub>.

#### *Carbon Monoxide*

Carbon monoxide is a by-product of incomplete combustion of organic matter (e.g., gasoline, wood and tobacco). Exposure to carbon monoxide can produce immediate and acute health affects. Several air quality standards have been established to address carbon monoxide and prevent symptoms from exposure to these substances. The MDPH established a corrective

action level concerning carbon monoxide in ice skating rinks that use fossil-fueled ice resurfacing equipment. If an operator of an indoor ice rink measures a carbon monoxide level over 30 ppm, taken 20 minutes after resurfacing within a rink, that operator must take actions to reduce carbon monoxide levels (MDPH, 1997).

The American Society of Heating Refrigeration and Air-Conditioning Engineers (ASHRAE) has adopted the National Ambient Air Quality Standards (NAAQS) as one set of criteria for assessing indoor air quality and monitoring of fresh air introduced by HVAC systems (ASHRAE, 1989). The NAAQS are standards established by the US EPA to protect the public health from six criteria pollutants, including carbon monoxide and particulate matter (US EPA, 2006). As recommended by ASHRAE, pollutant levels of fresh air introduced to a building should not exceed the NAAQS levels (ASHRAE, 1989). The NAAQS were adopted by reference in the Building Officials & Code Administrators (BOCA) National Mechanical Code of 1993 (BOCA, 1993), which is now an HVAC standard included in the Massachusetts State Building Code (SBBRS, 1997). According to the NAAQS, carbon monoxide levels in outdoor air should not exceed 9 ppm in an eight-hour average (US EPA, 2006). *Carbon monoxide should not be present in a typical, indoor environment.* If it is present, indoor carbon monoxide levels should be less than or equal to outdoor levels. On the day of the assessment, outdoor carbon monoxide concentrations were non-detect (ND) (Table 1). Carbon monoxide levels measured indoors were also ND (Table 1).

#### *Particulate Matter (PM<sub>2.5</sub>)*

The US EPA has established NAAQS limits for exposure to particulate matter. Particulate matter is airborne solids that can be irritating to the eyes, nose and throat. The

NAAQS originally established exposure limits to particulate matter with a diameter of 10  $\mu\text{m}$  or less (PM<sub>10</sub>). According to the NAAQS, PM<sub>10</sub> levels should not exceed 150 microgram per cubic meter ( $\mu\text{g}/\text{m}^3$ ) in a 24-hour average (US EPA, 2006). These standards were adopted by both ASHRAE and BOCA. Since the issuance of the ASHRAE standard and BOCA Code, the US EPA established a more protective standard for fine airborne particles. This more stringent PM<sub>2.5</sub> standard requires outdoor air particle levels be maintained below 35  $\mu\text{g}/\text{m}^3$  over a 24-hour average (US EPA, 2006). Although both the ASHRAE standard and BOCA Code adopted the PM<sub>10</sub> standard for evaluating air quality, MDPH uses the more protective PM<sub>2.5</sub> standard for evaluating airborne particulate matter concentrations in the indoor environment.

On August 3, 2007, outdoor PM<sub>2.5</sub> concentrations were measured at 125  $\mu\text{g}/\text{m}^3$  (Table 1). According to the US EPA, “[u]nhealthy ozone air quality is predicted in Connecticut, Rhode Island, and Massachusetts (except on the south coast, Cape Cod, and the Islands), and in coastal areas of New Hampshire and Maine for Friday, August 3, 2007. In addition, fine particle levels are expected to be elevated across New England...” (US EPA, 2007). Indoor PM<sub>2.5</sub> concentrations ranged from 78 to 91  $\mu\text{g}/\text{m}^3$ , which were above the NAAQS of 35  $\mu\text{g}/\text{m}^3$ , but below the outdoor air concentration (Table 1). In this instance, it is likely that outdoor PM<sub>2.5</sub> levels had a direct influence on the indoor PM<sub>2.5</sub> concentrations due to opened windows and deactivation of HVAC equipment in the DTA.

Frequently, indoor air levels of particulates can be at higher levels than those measured outdoors. A number of mechanical devices and/or activities that occur indoors can generate particulates during normal operation. Sources of indoor airborne particulate may include but are not limited to particles generated during the operation of fan belts in the HVAC

system, cooking in the cafeteria stoves and microwave ovens; use of photocopiers, fax machines and computer printing devices, operating an ordinary vacuum cleaner and heavy foot traffic indoors.

### *TVOCs*

Indoor air quality can also be negatively influenced by the presence of materials containing volatile organic compounds (VOCs). VOCs are carbon-containing substances that have the ability to evaporate at room temperature. Frequently, exposure to low levels of total VOCs (TVOCs) may produce eye, nose, throat and/or respiratory irritation in some sensitive individuals. Typical sources of VOCs from indoor sources include photocopiers, cleaners, health care/beauty products, dry erase materials, permanent markers, combustion sources, fabrics/textiles and paints. In an effort to determine whether VOCs were present in the building, air monitoring for TVOCs was conducted during the assessment. An outdoor air sample was taken for comparison. Outdoor TVOC concentrations were ND (Table 1). Indoor TVOC concentrations were ND in all areas surveyed (Table 1).

Finally, rodent traps were noted in several areas. Under current Massachusetts law (effective November 1, 2001) the principles of integrated pest management (IPM) must be used to remove pests in state buildings (Mass Act, 2000). Pesticide use indoors can introduce chemicals into the indoor environment that can be sources of eye, nose and throat irritation. The reduction/elimination of pathways/food sources that are attracting these insects should be the first step taken to prevent or eliminate infestation.

Rodent infestation can result in indoor air quality related symptoms due to materials in their wastes. Mouse urine is known to contain a protein that is a known sensitizer (US EPA, 1992). A sensitizer is a material that can produce symptoms including running nose or skin rashes in sensitive individuals. A three-step approach is necessary to eliminate rodent infestation:

1. Removal of the rodents;
2. Cleaning of waste products from the interior of the building; and
3. Reduction/elimination of pathways/food sources that are attracting rodents.

To eliminate exposure to allergens, rodents must be removed from the building. Please note that removal, even after cleaning, may not provide immediate relief since allergens can exist in the interior for several months after rodents are eliminated (Burge, 1995). A combination of cleaning, along with an increase in ventilation and filtration should serve to reduce rodent associated allergens once the infestation is eliminated.

## **Conclusions/Recommendations**

Some of the issues discussed in this assessment present conditions that could degrade indoor air quality. These conditions may also serve to exacerbate eye/respiratory irritation and other indoor air quality/comfort complaints. In view of the findings at the time of the visit, the following recommendations are made:

1. Ensure that the HVAC system has been properly repaired. Continue to coordinate with building management, administration, HVAC vendor and DTA/MRC staff to achieve/maintain optimal comfort levels.

2. Consider appointing a building liaison (and alternate) to coordinate efforts, facilitate communication and relay building-related concerns between occupants, administration and Shetland Park personnel.
3. For buildings in New England, periods of low relative humidity during the winter are often unavoidable. Therefore, scrupulous cleaning practices should be adopted to minimize common indoor air contaminants whose irritant effects can be enhanced when the relative humidity is low. To control for dusts, a high efficiency particulate arrestance (HEPA) filter equipped vacuum cleaner in conjunction with wet wiping of all surfaces is recommended. Drinking water during the day can help ease some symptoms associated with a dry environment (throat and sinus irritations).
4. Clean or replace all water damaged/mold contaminated materials (i.e., carpet under cooler) in a manner consistent with “Mold Remediation in Schools and Commercial Buildings” published by the US Environmental Protection Agency (US EPA, 2001). This document can be downloaded from the US EPA website at:  
[http://www.epa.gov/iaq/molds/mold\\_remediation.html](http://www.epa.gov/iaq/molds/mold_remediation.html). This measure will remove actively growing mold colonies that may be present. This work should be conducted at a time when occupants are not present in the area.
5. It highly recommended that the principles of integrated pest management (IPM) be used to rid the building of pest. A copy of the IPM recommendations can be obtained from the Massachusetts Department of Food and Agriculture (MDFA) website at the following website:  
[http://www.state.ma.us/dfa/pesticides/publications/IPM\\_kit\\_for\\_bldg\\_mgrs.pdf](http://www.state.ma.us/dfa/pesticides/publications/IPM_kit_for_bldg_mgrs.pdf).  
Activities that can be used to eliminate pest infestation may include the following:

- a. Avoid having food preparation or storage equipment in offices.
  - b. Rinse out recycled food containers. Seal recycled containers in a tight-fitting lid to prevent rodent access.
  - c. Remove non-food items that rodents are consuming.
  - d. Stored foods in tight fitting containers.
  - e. To the extent possible, avoid eating at workstations. In areas where food is consumed, periodic vacuuming to remove crumbs are recommended.
  - f. Regularly clean crumbs and other food residues from ovens, toasters, toaster ovens, microwave ovens coffee pots and other food preparation equipment;
  - g. Holes as small as 1/4" are enough space for rodents to enter an area. Examine each room and the exterior walls of the DSS office for means of rodent egress and seal. If doors do not seal at the bottom, install a weather strip as a barrier to rodents. Reduce harborages (e.g. discarded equipment and cardboard boxes) where rodents may reside (MDFA, 1996).
6. Refer to resource manuals and other related indoor air quality documents for further building-wide evaluations and advice on maintaining public buildings. Copies of these materials are located on the MDPH's website: [http://mass.gov/dph/indoor\\_air](http://mass.gov/dph/indoor_air).

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**Location: Massachusetts Department of Transitional Assistance**  
**Address: 35 Congress St., Salem, MA**

**Indoor Air Results**  
**Date: 8/3/2007**

**Table 1**

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
background		93	38	410	ND	ND	125	Y	Y	Y	
Regional Directors Office	1	85	57	730	ND	ND	89	Y	Y	Y	Door open
1	0	83	47	619	ND	ND	88	N	Y	Y	Door Open
94	2	83	48	629	ND	ND	88	N	Y	Y	
68	1	83	48	616	ND	ND	87	N	Y	Y	
109	5	82	49	608	ND	ND	88	N	Y	Y	
142	2	81	49	615	ND	ND	85	N	Y	Y	Water damaged carpet-water cooler
145	2	81	47	615	ND	ND	86	Y	Y	Y	
139	1	80	48	635	ND	ND	86	N	Y	Y	
137	0	80	48	632	ND	ND	84	N	Y	Y	
106	2	80	50	625	ND	ND	87	N	Y	Y	
87	2	81	51	631	ND	ND	89	N	Y	Y	

**Comfort Guidelines**

Carbon Dioxide: < 600 ppm = preferred  
600 - 800 ppm = acceptable  
> 800 ppm = indicative of ventilation problems

Temperature: 70 - 78 °F  
Relative Humidity: 40 - 60%

**Location: Massachusetts Department of Transitional Assistance**

**Address: 35 Congress St., Salem, MA**

**Indoor Air Results**

**Date: 8/3/2007**

**Table 1 (continued)**

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
71	2	81	51	649	ND	ND	86	N	Y	Y	
82	2	81	51	652	ND	ND	87	N	Y	Y	
Kitchen	0	83	57	692	ND	ND	91	Y	Y	Y	
37	5	82	50	629	ND	ND	91	N	Y	Y	
73	3	80	49	650	ND	ND	86	N	Y	Y	
63	4	79	48	654	ND	ND	87	N	Y	Y	
78	5	78	48	616	ND	ND	83	N	Y	Y	
100	6	77	48	614	ND	ND	81	N	Y	Y	
102	7	78	52	649	ND	ND	80	N	Y	Y	
80	5	77	49	610	ND	ND	78	N	Y	Y	
43	2	75	56	625	ND	ND	81	N	Y	Y	

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**Indoor Air Results**

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**Table 1 (continued)**

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
Conference room	0	75	56	637	ND	ND	81	N	Y	Y	
Provost	4	74	54	612	ND	ND	87	N	Y	Y	
80	1	74	54	620	ND	ND	83	N	Y	Y	
Cubicles near reception	2	78	54	616	ND	ND	81	N	Y	Y	
Waiting room	20	77	52	621	ND	ND	79	N	Y	y	

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**Location: Massachusetts Rehabilitation Commission**

**Address: 35 Congress St., Salem, MA**

**Indoor Air Results**

**Date: 8/3/2007**

**Table 2**

Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
background		93	38	410	ND	ND	125	Y	Y	Y	
Reception	1	80	44	628	ND	ND	87	Y	Y	N	
2	0	79	44	591	ND	ND	87	Y	Y	N	Door Open
Knowlton	0	78	44	571	ND	ND	85	Y	Y	N	
Kalfolopos	0	78	45	581	ND	ND	86	Y	Y	N	
Duffy	0	77	45	568	ND	ND	87	Y	Y	N	
Distefano	0	77	46	595	ND	ND	86	N	Y	N	
O'brien	0	76	46	663	ND	ND	86	N	Y	N	
Parmer	0	75	45	582	ND	ND	85	N	Y	N	
Jackson	0	75	46	571	ND	ND	85	N	Y	N	
Leshej	0	75	48	558	ND	ND	84	N	Y	N	
Coughlin	0	74	48	541	ND	ND	84	N	Y	N	

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Location/ Room	Occupants in Room	Temp (°F)	Relative Humidity (%)	Carbon Dioxide (ppm)	Carbon Monoxide (ppm)	TVOCs (ppm)	PM2.5 (µg/m3)	Windows Openable	Ventilation		Remarks
									Supply	Exhaust	
Kiton	0	74	50	584	ND	ND	84	N	Y	N	
Hong	0	74	50	592	ND	ND	84	N	Y	N	

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